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Component Failure Analysis From the U.S. Army ERDC/CERL Residential Proton Exchange Membrane Fuel Cells Demonstrations

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Outline

- Introduction
- Approach
- Data Analysis
- Results
- Conclusions
- Future

Introduction

- Project Background
  - 91 PEM units at 42 sites – contributed data
  - 12 month demonstrations
- Project Objectives
  - Assess the role of PEMs in DoD's missions
  - Perform operational test and validation
  - Assess performance in varying military installation environments
  - Stimulate growth in the industry
  - Evaluate system component failure

Approach

- Turn-key Packages Required
- Maximum Diversity Desired
- Minimum 1-Year “Fuel Cell Power” Required
  - Minimum 90% availability
  - Comprehensive maintenance contract
  - Monthly reports
  - Real world demonstration

PEM Demonstration Project Site Information

Year	Data Through	Fuel Usage, LHV (MBTUs)	Fuel Usage (SCF)	Energy Produced (kWe-hrs)	Thermal Heat Recovery (BTUs)	Average Output (kW)
FY01 Summary	05-Feb-06	1,719,410	1,617,535	112,352	83,494,948	2.57
FY02 Summary	28-Feb-06	1,991,444	1,949,820	137,069	289,654,133	2.65
FY03 Summary	30-Apr-06	630,680	651,852	45,301	120,920	2.31
Total Fleet Summary	28-Feb-06	4,341,535	4,219,206	294,722	373,270,001	2.56

PEM Demonstration Project Site Information

Year	Operating Hours	Availability	Capacity Factor	Electrical Efficiency	Thermal Efficiency	Overall Efficiency
FY01 Summary	43,699	91%	45%	22%	14%	29%
FY02 Summary	51,804	89%	40%	23%	18%	37%
FY03 Summary	19,653	88%	17%	25%	6%	25%
Total Fleet Summary	115,155	89%	30%	23%	17%	32%

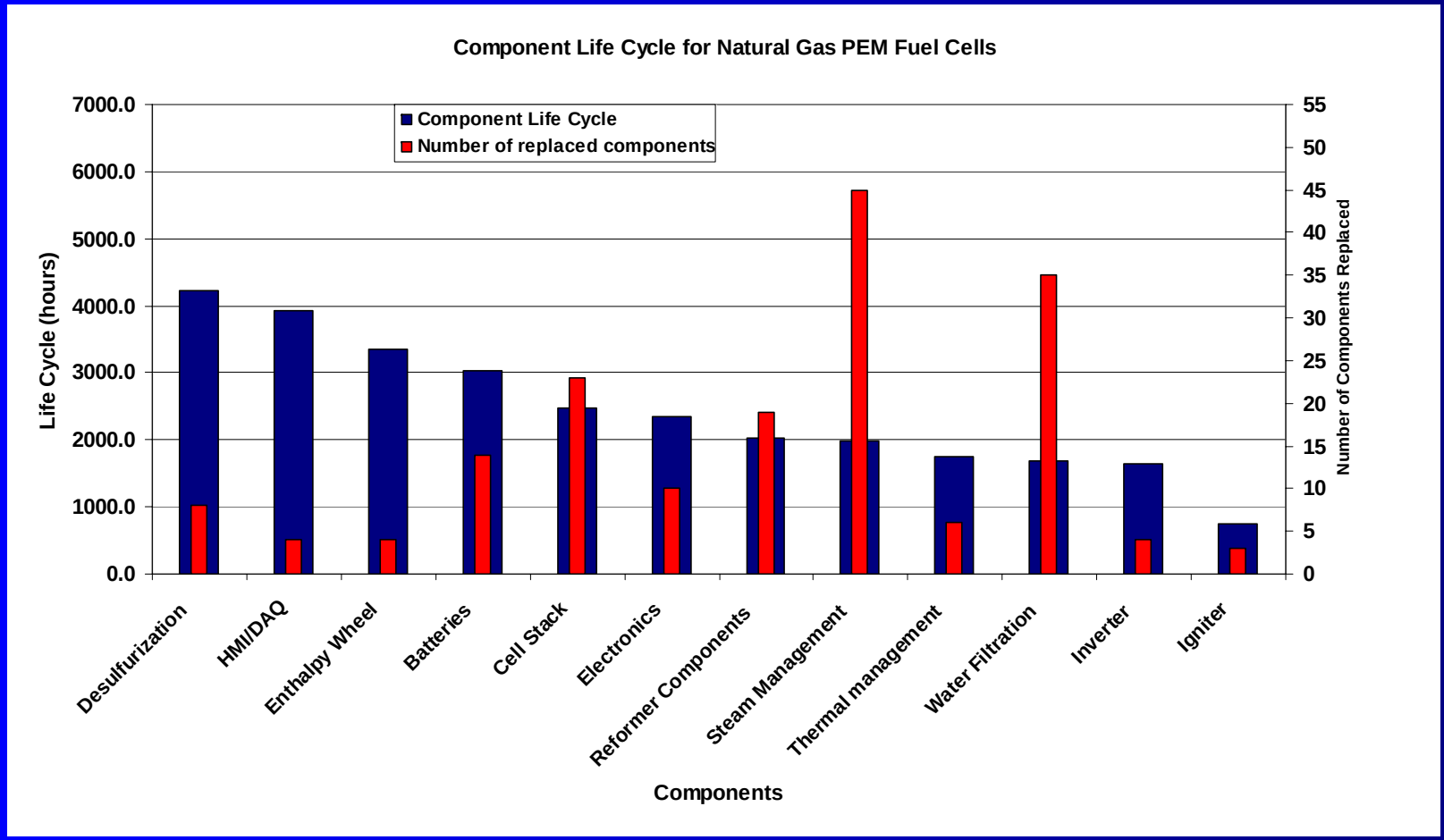
PEM Demonstration Project Site Information

Year	Number of Scheduled Outages	Scheduled Outage Hours	Number of Unscheduled Outages	Unscheduled Outage Hours	Mean Time of Scheduled Outages	Mean Time of Unscheduled Outages
FY01 Summary	28	2286	77	3506	82	46
FY02 Summary	35	2381	350	12057	68	34
FY03 Summary	5	45	60	3456	9	58
Total Fleet Summary	68	4712	487	19018	69	39

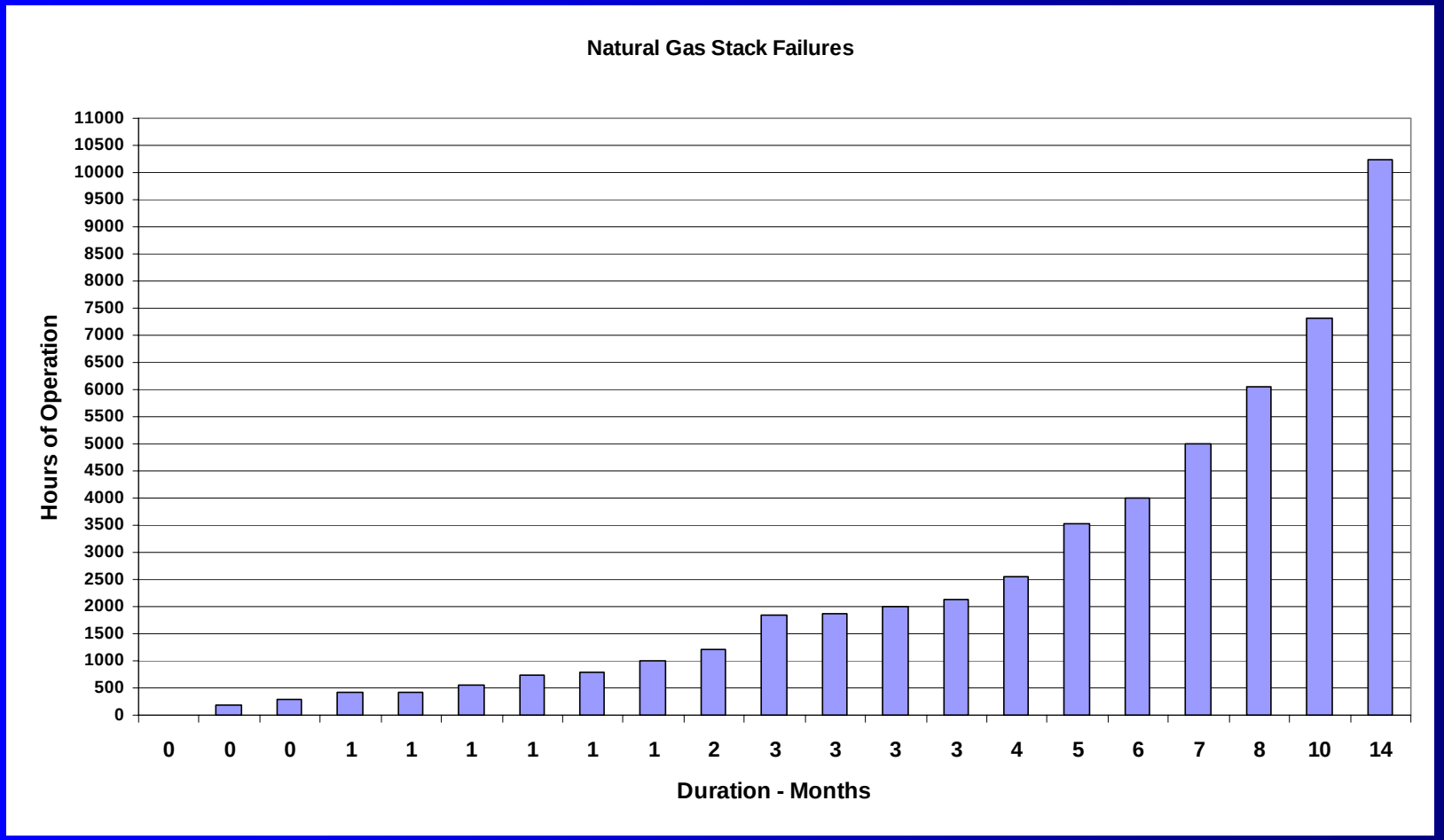
Data Analysis – Component Failure

- Primary Power
  - Natural gas systems
  - LPG systems
- Backup Power
  - Hydrogen systems

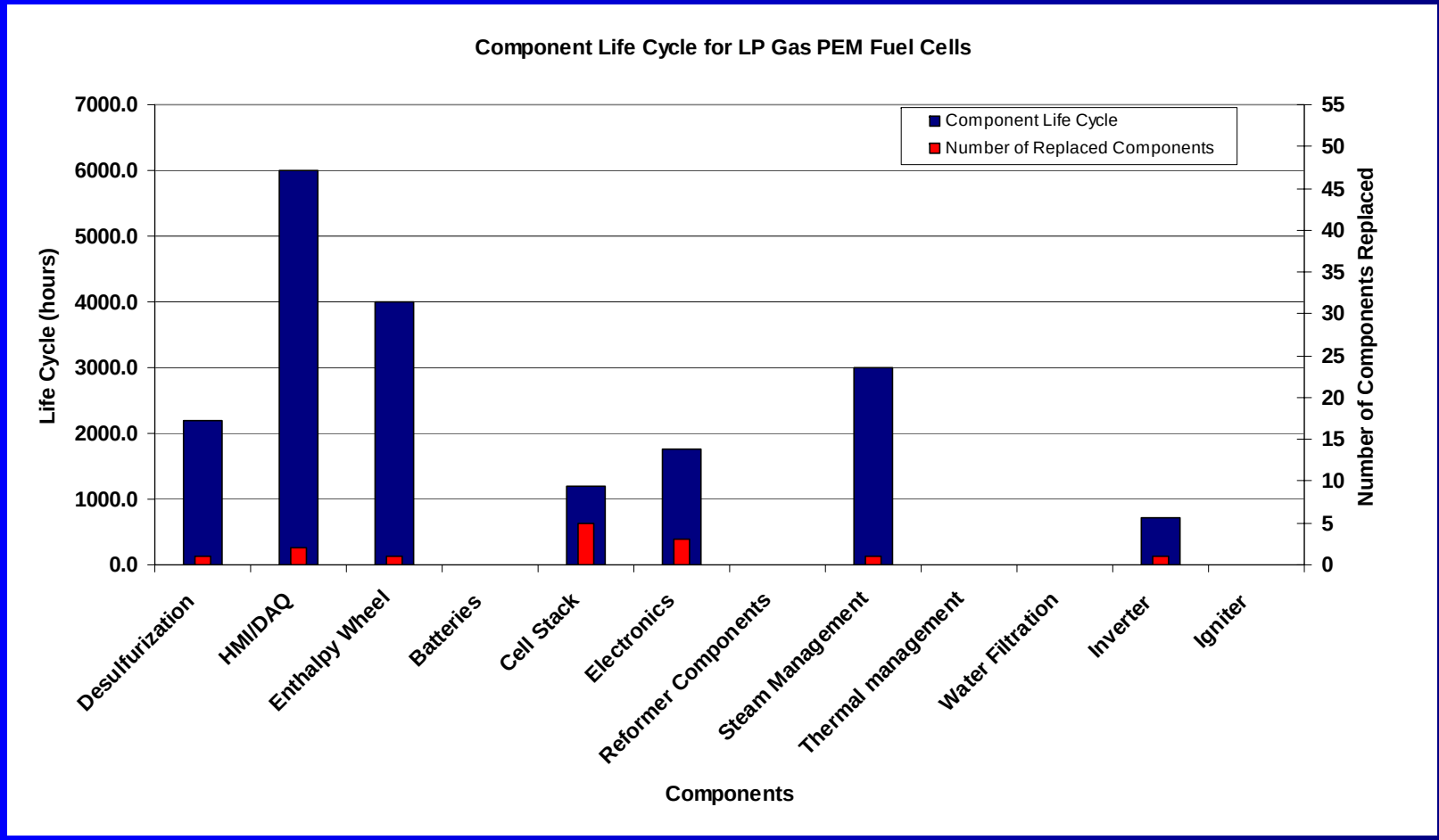
Primary Power – Natural Gas



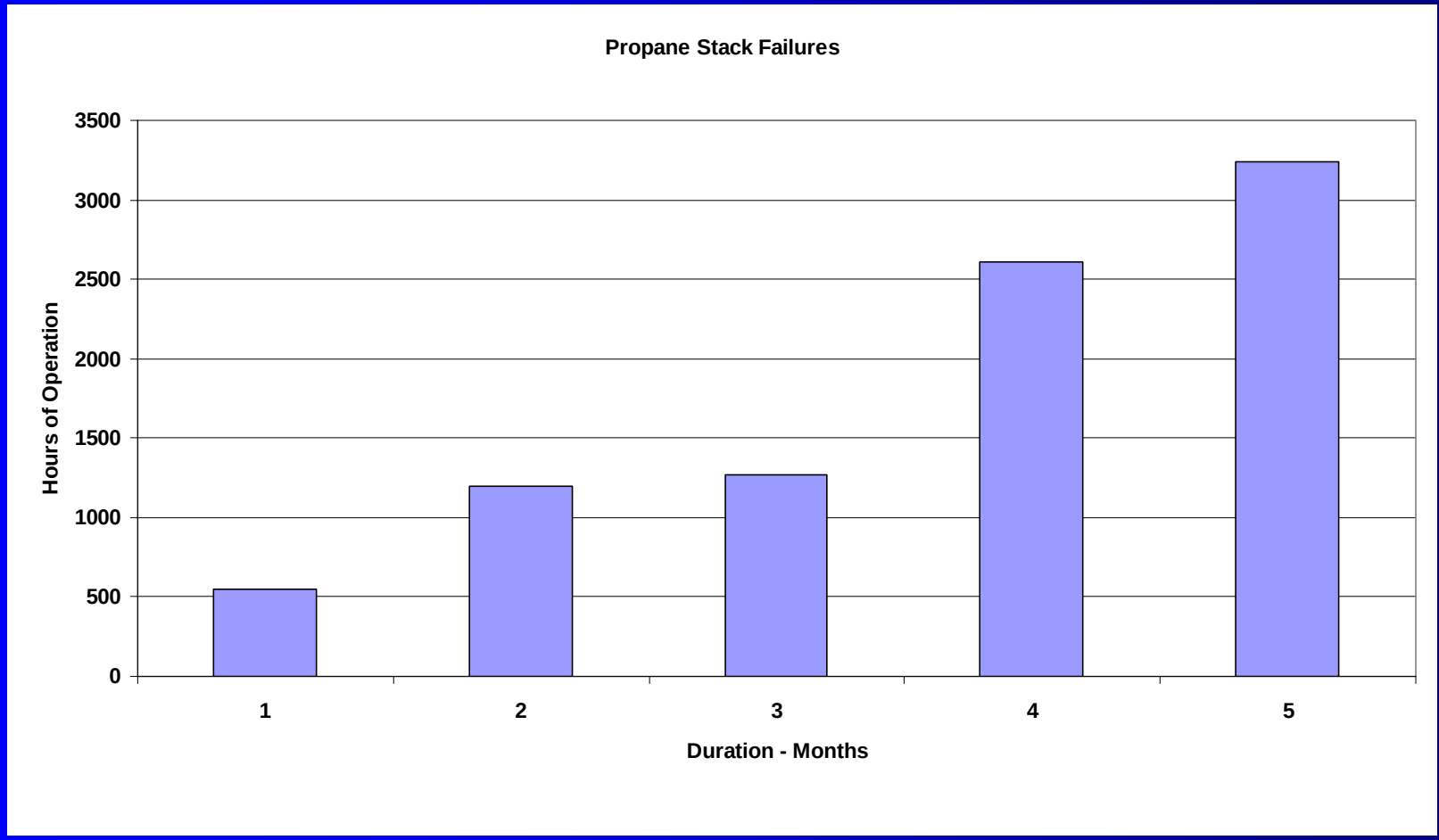
Primary Power – Natural Gas



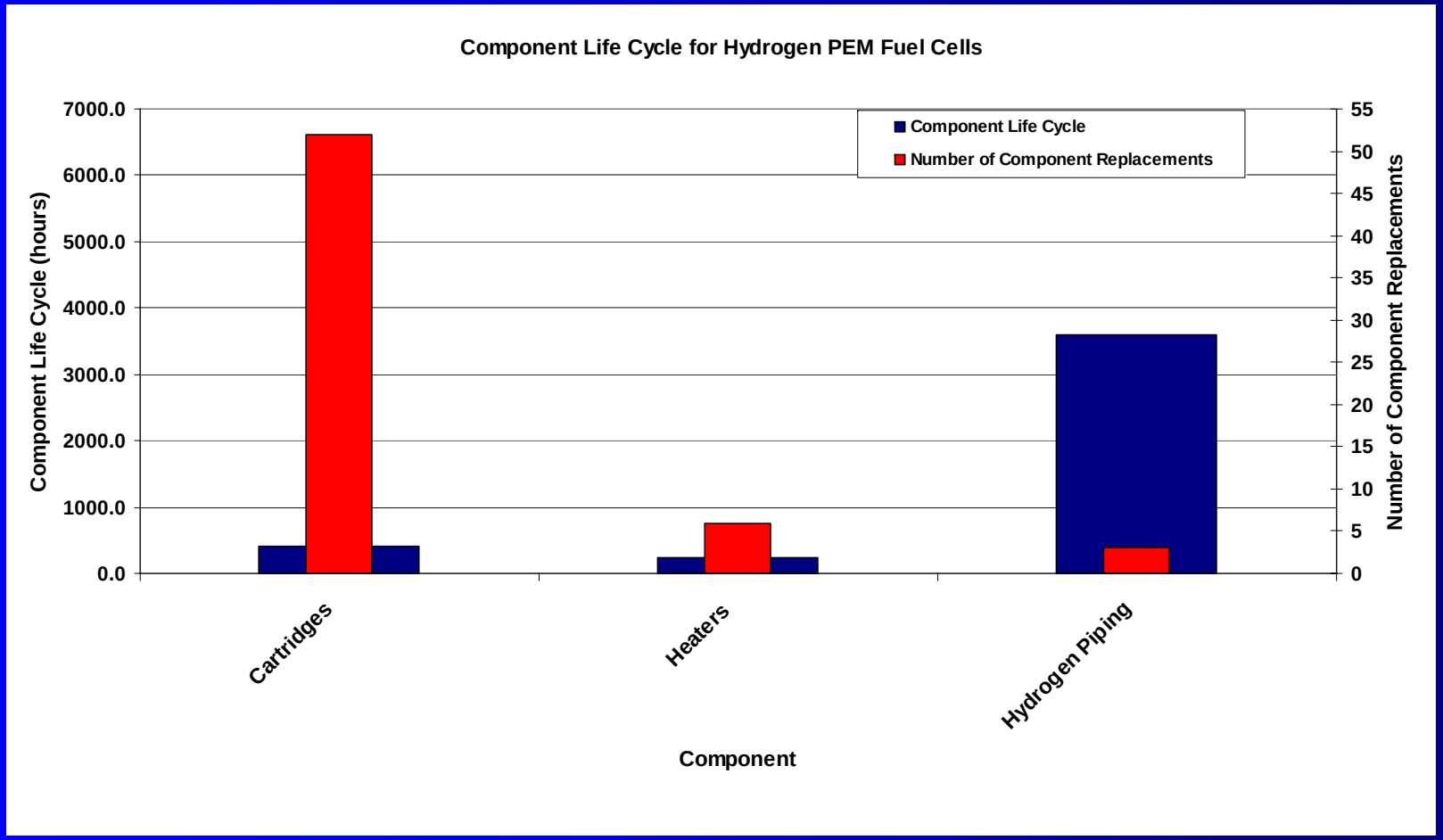
Primary Power – LPG



Primary Power – LPG



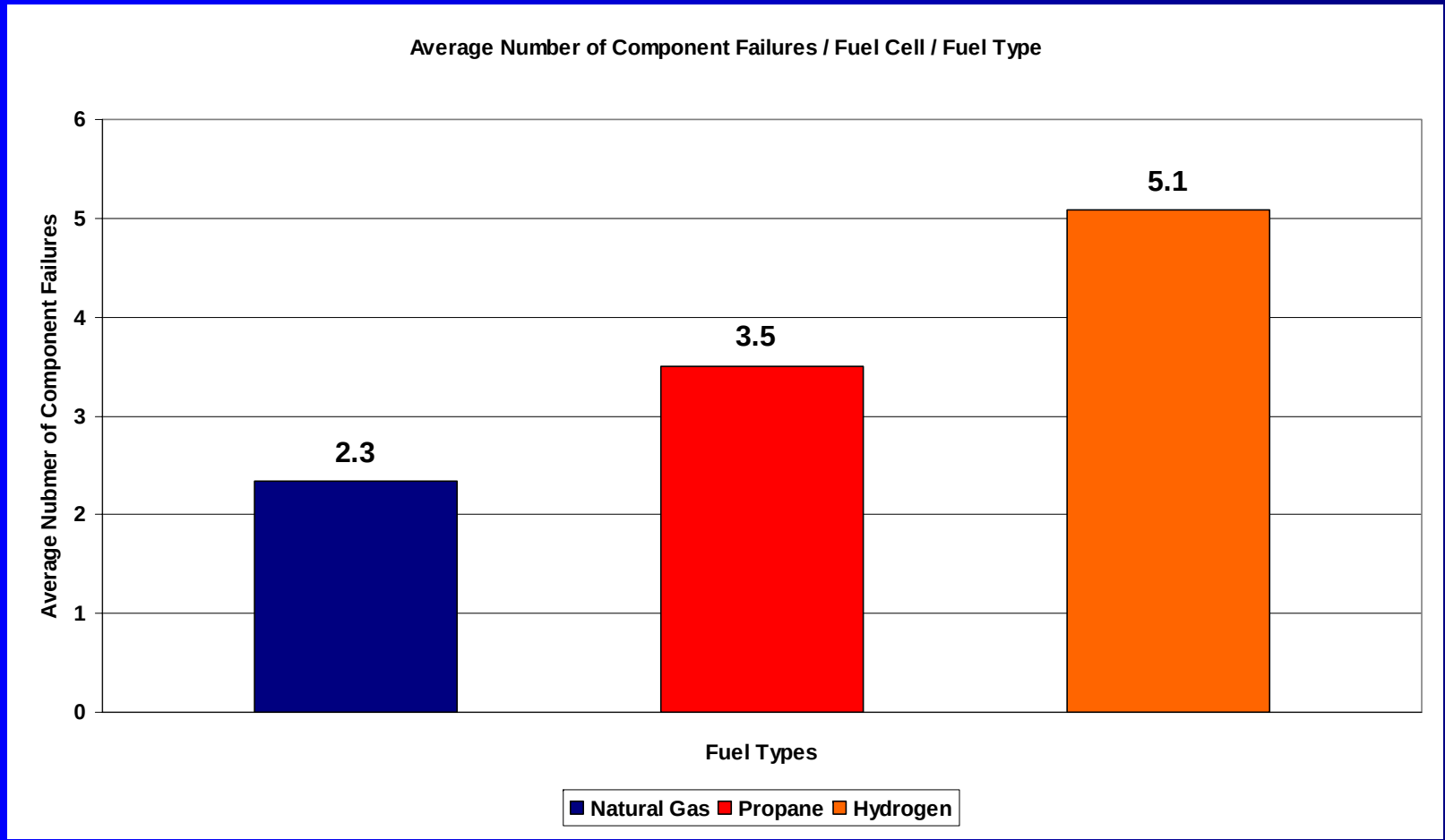
Backup Power – Hydrogen



Backup Power – Hydrogen

- Unique Systems
  - Used an array of small fuel cell cartridges instead of a solid cell stack
  - Individually replaced without disrupting operation of other cartridges
- Operated as Backup Generators
  - Only operated for one to two hours per day
- Cartridges Were Replaced After an Average of 190 Hours

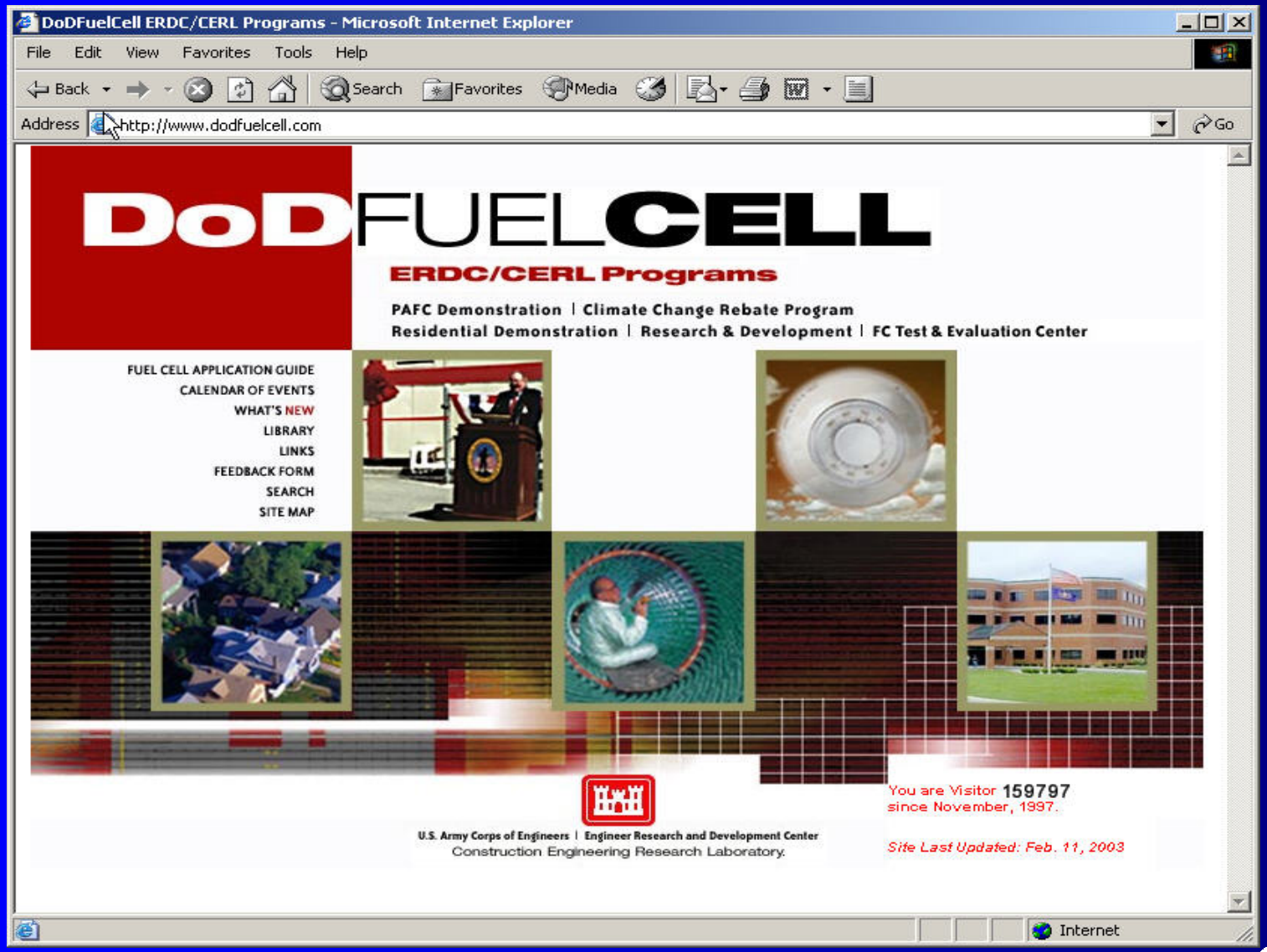
Results


Average Number of Component Failures / Fuel Cell / Fuel Type
Average Nubmer of Component Failures
0
1
2
3
4
5
6
2.3
3.5
5.1
Fuel Types
Natural Gas
Propane
Hydrogen

Future

- Analysis is On-going
- More systems Contributing Data
  - Broader field of data
  - More developed patterns of component failure
- Alternative type of Hydrogen Fueled Backup Power System

www.dodfuelcell.com



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